

CONCRETE I

COURSE DESCRIPTION

Concrete I is a course that will introduce students to basic skills and knowledge related to reinforced concrete construction in residential and commercial structures. Topics covered include safe practices, drawing interpretation, composition of concrete, principles of reinforcement, form construction, load analysis, and placing, curing and testing concrete. This course gives students an introduction to the skill and knowledge base typically required for apprentice concrete artisan.

Prerequisite(s):

Core Construction

Algebra I or Math for Technology II (may be concurrent)

Recommended Credits:

2

Recommended Grade Level(s):

11th

CONCRETE I STANDARDS

- 1.0 Students will demonstrate leadership, citizenship, and teamwork skills required for success in the school, community, and workplace.
- 2.0 Students will take personal responsibility for the safety of themselves, their coworkers, and bystanders.
- 3.0 Students will interpret, lay out, and fabricate in conformance to construction drawings and written specifications.
- 4.0 Students will analyze the composition of concrete mixtures and relate the variations in mixtures to the properties of concrete.
- 5.0 Students will analyze and apply the design principles of reinforced concrete structural members.
- 6.0 Students will demonstrate foundation layout, form construction, and reinforcement placement.
- 7.0 Students will explain and demonstrate techniques for placing concrete.
- 8.0 Students will describe and demonstrate techniques for curing concrete.
- 9.0 Students will perform common tests on concrete and components.
- 10.0 Students will analyze the loads that act on concrete structures.

CONCRETE I

STANDARD 1.0

Students will demonstrate leadership, citizenship, and teamwork skills required for success in the school, community, and workplace.

LEARNING EXPECTATIONS

The student will:

- 1.1 Cultivate leadership skills.
- 1.2 Participate in SkillsUSA-VICA as an integral part of instruction.
- 1.3 Assess situations within the school, community, and workplace and apply values to develop and select solutions.
- 1.4 Demonstrate the ability to work cooperatively with others.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

- 1.1.A Takes initiative in meetings to actively influence the results of deliberations.
- 1.1.B Uses critical-thinking and consensus building skills in group deliberations.
- 1.2.A Applies high ethical standards to personal, community, and professional situations.
- 1.2.B Participates and conducts meetings according to accepted rules of parliamentary procedure.
- 1.3.A Analyzes simulated workplace situations and uses problem-solving and critical-thinking techniques to suggest solutions the problem.
- 1.3.B Analyzes socio-economic conflicts associated with the construction industry and applies values to evaluate possible ways to mitigate the conflicts.
- 1.4.A Participates in a committee.
- 1.4.B Contributes to a group project.

SAMPLE PERFORMANCE TASKS

- Create a leadership inventory and use it to conduct a personal assessment.
- Participate in various SkillsUSA-VICA or similar programs and/or competitive events.
- Evaluate a civic project within the school, community, and/or workplace and evaluate the expected long term effects of the project.
- Prepare a meeting agenda for a school or community meeting.
- Attend the meeting of a professional organization.
- Participate in a design team to complete an assigned project.

INTEGRATION LINKAGES

SkillsUSA-VICA, *Professional Development Program*, SkillsUSA-VICA, Communication and Writing Skills, Teambuilding Skills, Research, Language Arts, Sociology, Psychology, Algebra, Geometry, Applied Communication, Social Studies, Problem Solving, Interpersonal Skills, Employability Skills, Critical-Thinking Skills, SCANS (Secretary's Commission on Achieving Necessary Skills), Chamber of Commerce, Colleges, Universities, Technology Centers, and Employment Agencies

CONCRETE I

STANDARD 2.0

Students will take personal responsibility for the safety of themselves, their coworkers, and bystanders.

LEARNING EXPECTATIONS

The student will:

- 2.1 Demonstrate a positive attitude regarding safety practices and issues.
- 2.2 Use and inspect personal protective equipment.
- 2.3 Inspect, maintain, and employ safe operating procedures with tools and equipment, such as hand and power tools, ladders, scaffolding, and lifting equipment.
- 2.4 Continuously respond to potential hazards to self and others.
- 2.5 Assume personal responsibilities under HazCom (Hazard Communication) regulations.
- 2.6 Assume responsibilities, regulations, and company policies to protect coworkers and bystanders from hazards.
- 2.7 Adhere to responsibilities, regulations, and company policies regarding reporting of accidents and observed hazards, and regarding emergency response procedures.
- 2.8 Demonstrate appropriate related safety procedures.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

- 2.1.A Is attentive during safety discussions.
- 2.1.B Actively seeks information about safe procedures.
- 2.1.C Responds positively to instruction, advice, and correction regarding safety issues.
- 2.1.D Does not deliberately create or increase hazards, such as by horseplay, practical jokes, or creating distractions.
- 2.1.E Reports to school or work physically ready to perform to professional standards, such as rested, or not impaired by medications, drugs, alcohol, etc.
- 2.2.A Selects, inspects, and uses the correct personal protective equipment for the assigned task.
- 2.3.A Inspects power tools for intact guards, shields, insulation, and other protective devices.
- 2.3.B Inspects extension cords for the presence of a functional ground connection, prior to use.
- 2.3.C Operates and maintains tools in accordance with manufacturer's instructions and as required by regulation or company policy.
- 2.3.D Properly places and secures ladders and scaffolding prior to use.
- 2.4.A Is observant of personnel and activities in the vicinity of the work area.
- 2.4.B Warns nearby personnel, prior to starting potentially hazardous actions.
- 2.5.A When tasked to use a new hazardous material, retrieves MSDSs, (material safety data sheets) and identifies the health hazards associated with the new material.
- 2.5.B Reports hazards found on the job site to the supervisor.
- 2.6.A Erects shields, barriers, and signage to protect coworkers and bystanders prior to starting potentially hazardous tasks.
- 2.6.B Provides and activates adequate ventilation equipment as required by the task.
- 2.7.A Reports all injuries to self to the immediate supervisor.
- 2.7.B Reports observed unguarded hazards to the immediate supervisor.
- 2.7.C Complies with personal assignments regarding emergency assignments.

- 2.8.A Passes with 100 % accuracy a written examination relating to safety issues.
- 2.8.B Passes with 100% accuracy a performance examination relating to safety.
- 2.8.C Maintains a portfolio record of written safety examinations and equipment examinations for which the student has passed an operational checkout by the instructor.

SAMPLE PERFORMANCE TASKS

- Practice drill simulating a hazardous solvent spill in which an emergency action plan is to be implemented.
- Instruct a visitor to obviously approach the vicinity of a student conducting a hazardous activity, and note the level of awareness demonstrated by the student.
- For a project requiring the use of ladders and/or scaffolding, note the proper placement and securing procedures followed by students.

INTEGRATION LINKAGES

Science, Computer Skills, Research and Writing Skills, Language Arts, Communication Skills, Leadership Skills, Teamwork Skills, Algebra, Geometry, Applied Communication, Secretary's Commission on Achieving Necessary Skills (SCANS), Skills USA-VICA, Associated Builders and Contractors (ABC), Associated General Contractors (AGC), National Center for Construction Education and Research (NCCER), Occupational Safety and Health Administration (OSHA), Environmental Protection Agency, United States Department of Labor, Tennessee Department of Labor and Workforce Development

CONCRETE I

STANDARD 3.0

Students will interpret, lay out, and fabricate in conformance to construction drawings and written specifications.

LEARNING EXPECTATIONS

The student will:

- 3.1 Interpret dimensions and locations of components that are explicitly dimensioned in construction drawings and written specifications.
- 3.2 Interpret plan and elevation views shown in construction drawings.
- 3.3 Recognize and correctly interpret lines and symbols commonly used in construction drawings.
- 3.4 Make layouts of locations and elevations of concrete structural elements and reinforcements.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

- 3.1.A Makes a material take-off in conformance to construction drawings and specifications.
- 3.1.B Lays out components, structural and others, and their locations to dimensions and tolerances indicated on construction drawings and written specifications.
- 3.2.A Interprets three-dimensional features found in construction drawings.
- 3.3.A Distinguishes between object lines, dimension and extension lines, center lines, section lines, and other lines commonly found in construction drawings.
- 3.3.B Identifies symbols commonly used in construction drawings, including material, window and door, electrical, plumbing, HVAC, and plot plan and survey symbols.
- 3.3.C Correlates symbols in construction drawings for concrete reinforcement and finished details with their physical locations.
- 3.4.A Lays out locations and elevations of concrete structures, based on construction drawings.
- 3.4.B Lays out locations for steel reinforcement, joints, and imbedded items based on construction drawings.

SAMPLE PERFORMANCE TASKS

- Given a set of plans and specifications for a residential or commercial structure, make a complete material take-off for the concrete structures.
- Given a set of plans and specifications for a residential or commercial structure, determine the location of concrete structures or features not explicitly dimensioned.
- Determine the coordination required to allow rough-in with other trades such as electrical and plumbing during a construction project.

INTEGRATION LINKAGES

Science, Computer Skills, Research and Writing Skills, Language Arts, Communication Skills, Leadership Skills, Teamwork Skills, Algebra, Geometry, Applied Communication, Secretary's Commission on Achieving Necessary Skills (SCANS), Skills USA-VICA, Associated Builders and Contractors (ABC), Associated General Contractors (AGC), National Center for Construction Education and Research (NCCER), Occupational Safety and Health Administration (OSHA), Environmental Protection Agency, United States Department of Labor, Tennessee Department of Labor and Workforce Development

CONCRETE I

STANDARD 4.0

Students will analyze the composition of concrete mixtures and relate the variations in mixtures to the properties of concrete.

LEARNING EXPECTATIONS

The student will:

- 4.1 Analyze the choices of aggregate available to make concrete and their relative costs.
- 4.2 Explain the production methods, chemical reactions, and properties of hydraulic (Portland) cement.
- 4.3 Examine the various types of aggregate used to make concrete and their applications.
- 4.4 Relate variations in the composition of concrete with the compressive strength of concrete.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

- 4.1.A Contrasts the various aggregates used to make concrete for different applications.
- 4.1.B Compares and contrasts the composition and use of masonry grout, pumpable concrete, and lightweight concrete.
- 4.1.C Researches the relative cost of concrete aggregates delivered to mixing sites in your area.
- 4.2.A Explains the raw materials and processes used to produce hydraulic cement.
- 4.2.B Explains the chemical processes that occur as concrete sets.
- 4.3.A Compares and contrasts the types of aggregate used to make concrete for various common structural components such as beams, columns, foundations, and roof decks.
- 4.3.B Compares and contrasts the composition and use of lightweight concrete in commercial and residential construction.
- 4.4.A Examines and demonstrates the effect of the water:cement ratio on the compressive strength of concrete.
- 4.4.B Examines and demonstrates the effect of aggregate strength on the compressive strength of concrete.
- 4.4.C Examines and demonstrates the effect of admixtures on the compressive strength of concrete.

SAMPLE PERFORMANCE TASKS

- Research and report on the history of hydraulic cement.
- Research engineering data and report on the strength and composition of various types of concrete.
- Determine the components and proportions to make concrete with a specific 7-day compressive strength and a specific maximum aggregate size. Calculate exact weights of each component to cast four test cylinders. Show all calculations and site sources for engineering data.
- Cast, cure, and test concrete samples designed in the previous performance task.

INTEGRATION LINKAGES

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CONCRETE I

STANDARD 5.0

Students will analyze and apply the design principles of reinforced concrete structural members.

LEARNING EXPECTATIONS

The student will:

- 5.1 Compare and contrast compressive and tensile strengths of materials.
- 5.2 Compare and contrast the regions of compression and tension in various beams, columns, and slabs.
- 5.3 Relate the placement of reinforcing steel in concrete to the distribution of compression and tension in structures.
- 5.4 Quantify the maximum reaction forces and moments that could be developed by simple reinforced concrete beams and columns.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

- 5.1.A Demonstrates and compares the relative forces needed to break (tension or shear) or crush (compress) cast concrete samples (having no reinforcement).
- 5.2.A Predicts failure modes for different configurations of load and support of model beams (e.g., Styrofoam, cardboard, etc.), and then load to failure.
- 5.2.B Demonstrates the improved performance of model Styrofoam beams when tension reinforcement (e.g., fiberglass tape) is added to the top or bottom.
- 5.3.A Analyzes construction drawings of beams and deduces where the designer expected the beam to experience tensile stress based on the placement of major steel reinforcement.
- 5.3.B Examines the placement and relative size of steel reinforcement in large concrete columns and relates it to the expected loads.
- 5.4.A Quantifies the compressive and tensile strength of a specified rectangular concrete beam.
- 5.4.B Quantifies the maximum reaction moment of a specified rectangular concrete beam.

SAMPLE PERFORMANCE TASKS

- Take a field trip to observe large-scale form construction and reinforcement installation.
- Have a contest to achieve minimum deflection under load of thin-shell (less than two inches thick) slabs with student designed reinforcements.
- Design and build a one-way reinforced model slab using Styrofoam and reinforcing tape, able to withstand a specified load and specified maximum deflection.

INTEGRATION LINKAGES

Science, Computer Skills, Research and Writing Skills, Language Arts, Communication Skills, Leadership Skills, Teamwork Skills, Algebra, Geometry, Applied Communication, Secretary's Commission on Achieving Necessary Skills (SCANS), Skills USA-VICA, Associated Builders and Contractors (ABC), Associated General Contractors (AGC), National Center for Construction Education and Research (NCCER), Occupational Safety and Health Administration (OSHA), Environmental Protection Agency, United States Department of Labor, Tennessee Department of Labor and Workforce Development

CONCRETE I

STANDARD 6.0

Students will demonstrate foundation layout, form construction, and reinforcement placement.

LEARNING EXPECTATIONS

The student will:

- 6.1 Perform site layout based on control points and construction drawings.
- 6.2 Construct forms for on-grade slab and beam foundations.
- 6.3 Place and secure reinforcement as detailed by construction drawings and specifications.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

- 6.1.A Marks locations and elevations of site layouts based on control points and construction drawings.
- 6.1.B Determines excavation or backfill requirements for slab and beam foundation.
- 6.2.A. Constructs, places, and braces forms for foundation concrete as detailed in construction drawings.
- 6.2.B Marks locations and grades for rough-in by other trades.
- 6.3.A Places and secures reinforcement as detailed by construction drawings, building codes, and industry practice.
- 6.3.B Writes a detailed operation and logistics plan for placing, finishing, and curing the concrete.

SAMPLE PERFORMANCE TASKS

- Set up batter boards, foundation lines, and grade stakes for a residential or a small commercial building.
- Make estimates of backfill or excavation needed for the foundation of a residential or a small commercial building.
- Draft an elevation profile of a driveway or approach road to the school.

INTEGRATION LINKAGES

Science, Algebra, Geometry, History, Computer Skills, Communication Skills, Teamwork Skills, Secretary's Commission on Achieving Necessary Skills, Skills USA-VICA, Occupational Safety and Health Administration, Environmental Protection Agency, National Center for Construction Education and Research

CONCRETE I

STANDARD 7.0

Students will explain and demonstrate techniques for placing concrete.

LEARNING EXPECTATIONS

The student will:

- 7.1 Compare and contrast techniques for moving concrete to the point of placement.
- 7.2 Explain and demonstrate the requirements of good artisanship in placing concrete in forms.
- 7.3 Explain and demonstrate techniques for consolidating concrete.
- 7.4 Explain and demonstrate common hand and power tools and processes to finish concrete.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

- 7.1.A Describes the placing sequence patterns for large slabs and small slabs.
- 7.1.B Compares and contrasts systems for moving concrete to the point of placement in residential and commercial construction.
- 7.2.A Demonstrates slump tests.
- 7.2.B Demonstrates the use of the basic tools and equipment for placing concrete.
- 7.3.A Explains the objectives of consolidating concrete.
- 7.3.B Demonstrates techniques for consolidating concrete in slabs, beams, and columns.
- 7.4.A Demonstrates screeding of concrete.
- 7.4.B Demonstrates techniques and tools for finishing slabs.

SAMPLE PERFORMANCE TASKS

- Draft a detailed operational plan to place, consolidate, and finish concrete in a residential slab and beam foundation, including time schedule, equipment, and labor requirements.
- Demonstrate placing, consolidating, finishing, and curing a small concrete slab.
- Write a report on concrete placing, consolidating, and finishing operations observed on a field trip.

INTEGRATION LINKAGES

Science, Computer Skills, Research and Writing Skills, Language Arts, Communication Skills, Leadership Skills, Teamwork Skills, Algebra, Geometry, Applied Communication, Secretary's Commission on Achieving Necessary Skills (SCANS), Skills USA-VICA, Associated Builders and Contractors (ABC), Associated General Contractors (AGC), National Center for Construction Education and Research (NCCER), Occupational Safety and Health Administration (OSHA), Environmental Protection Agency, United States Department of Labor, Tennessee Department of Labor and Workforce Development

CONCRETE I

STANDARD 8.0

Students will describe and demonstrate techniques for curing concrete.

LEARNING EXPECTATIONS

The student will:

- 8.1 Explain and demonstrate the effects of curing time on ultimate strength and abrasion resistance.
- 8.2 Explain and demonstrate techniques for optimum curing under all weather conditions.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

- 8.1.A Researches and reports on curing process to achieve the highest ultimate strength of concrete.
- 8.1.B Explains observable surface defects caused by fast surface curing.
- 8.2.A Demonstrates techniques for maintaining moisture during curing.
- 8.2.B Explains and demonstrates cold weather curing techniques.
- 8.2.C Explains and demonstrates hot weather curing techniques.

SAMPLE PERFORMANCE TASKS

- Compare results from destructive testing of concrete samples cured under optimal versus adverse conditions.
- Demonstrate the adverse effects of rapid surface drying of concrete slab.

INTEGRATION LINKAGES

Science, Algebra, Geometry, History, Computer Skills, Communication Skills, Teamwork Skills, Secretary's Commission on Achieving Necessary Skills, Skills USA-VICA, Occupational Safety and Health Administration, Environmental Protection Agency, National Center for Construction Education and Research, International Concrete Repair Institute (ICRI)

CONCRETE I

STANDARD 9.0

Students will perform common tests on concrete and components.

LEARNING EXPECTATIONS

The student will:

- 9.1 Perform slump tests and apply acceptance criteria on concrete.
- 9.2 Cast, cure, and test concrete samples for compressive strength.
- 9.3 Test aggregates for size distribution and density.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

- 9.1.A Performs slump tests on concrete and accept or reject based on specifications.
- 9.1.B Adjusts the moisture content of a concrete mixture that failed a slump test to meet specifications, if possible.
- 9.2.A Casts test samples in accordance with specifications and applicable codes.
- 9.2.B Cures and tests concrete samples in accordance with specifications and applicable codes.
- 9.3.A Screens samples of concrete aggregates and compares size distribution with specifications.
- 9.3.B Determines the density of all separated sizes of aggregate for a test batch of concrete.

SAMPLE PERFORMANCE TASKS

- Determine and record the density of all aggregates available for student use at the school.
- Measure and compare the compressive strength of test samples cast with different water-to-cement ratios.

INTEGRATION LINKAGES

Science, Computer Skills, Research and Writing Skills, Language Arts, Communication Skills, Leadership Skills, Teamwork Skills, Algebra, Geometry, Applied Communication, Secretary's Commission on Achieving Necessary Skills (SCANS), Skills USA-VICA, Associated Builders and Contractors (ABC), Associated General Contractors (AGC), National Center for Construction Education and Research (NCCER), Occupational Safety and Health Administration (OSHA), Environmental Protection Agency, United States Department of Labor, Tennessee Department of Labor and Workforce Development

CONCRETE I

STANDARD 10.0

Students will analyze the loads that act on concrete structures.

LEARNING EXPECTATIONS

The student will:

- 10.1 Analyze vertical loads on masonry structures.
- 10.2 Analyze lateral loads on masonry structures.
- 10.3 Analyze how masonry structures develop reaction to applied loads.

PERFORMANCE STANDARDS: EVIDENCE STANDARD IS MET

The student:

- 10.1.A Determines live loads on floor and roof structures for residential and commercial buildings based on intended use and the building codes.
- 10.1.B Determines dead loads on masonry structural components such as walls and columns for residential and commercial buildings based on construction drawings or proposed designs
- 10.2.A Determines lateral wind loads on residential and commercial buildings based on location, weather history, and building codes.
- 10.2.B Determines lateral loads on a retaining wall.
- 10.3.A Solves static equilibrium problems, including those with multiple point forces and distributed forces.
- 10.3.B Analyzes reaction forces and moments required of simple beam and column structures, subject to point and distributed loads
- 10.3.C Designs reinforced concrete column, beam, and wall structures for given loads in accordance with industry practice and building codes.

SAMPLE PERFORMANCE TASKS

- Determine live loads for a two-story commercial structure to be used as a print shop.
- Determine dead loads on a wall by analysis of blueprints for a residential or small commercial structure.
- Determine the lateral loads on a masonry retaining wall for a specified application, and propose a design.

INTEGRATION LINKAGES

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SAMPLING OF AVAILABLE RESOURCES

Books

- *Core Curriculum*, National Center for Construction Education and Research (NCCER). Prentice Hall, Upper Saddle River, NJ; ©2000. Also known as the “Wheels of Learning” materials.
- *Concrete Finishing Level One*, National Center for Construction Education and Research (NCCER). Prentice Hall, Upper Saddle River, NJ; ©1998. Also known as the “Wheels of Learning” materials.
- *Concrete Finishing Level Two*, National Center for Construction Education and Research (NCCER). Prentice Hall, Upper Saddle River, NJ; ©1999. Also known as the “Wheels of Learning” materials.
- *Creating with Concrete: Yard Art, Sculpture and Garden Projects*, Sherri Warner Hunter, Lark Books, 2001.
- *Concrete Construction Handbook*, Joseph A. Dobrowolski, McGraw-Hill Professional Book Group, June 1998.
- *Construction Manual: Concrete and Formwork*, T. W. Love, Craftsman Book Company, October 1979.
- *Concrete, Masonry and Brickwork: A Practical Handbook for the Home Owner and Small Builder*, U. S. Department of the Army, Dover Publications, Inc., August 1999.
- *Concrete Construction and Estimating*, Craig Avery, Craftsman Book Company, November 1983.
- *Foundations and Concrete Work*, Editors of Fine Homebuilding, Taunton Press, Inc., December 2001.
- *Formwork for Concrete Structures*, Robert L. Peurifoy, Garold D. Oberlender, McGraw-Hill Professional Book Group, October 1995.
- *Masonry and Concrete*, C. Beall, McGraw-Hill Professional Book Group, August 2000.
- *Concrete Repair and Maintenance Illustrated: Problem Analysis, Repair Strategy, Techniques*, Peter Emmons and Brandon W. Emmons, A Construction Means Data Group Company, July 1992.

Organizations

- American Concrete Institute International, <http://www.aci-int.org/>
- American Society for Testing and Materials , <http://www.astm.org/>
- Building Officials and Code Administrators International, <http://www.bocai.org/index.html>
- Concrete Masonry Online, National Concrete Masonry Association, www.ncma.org
- International Concrete Repair Institute, <http://www.icri.org/>
- Portland Cement Association, <http://www.portcement.org/index.asp>
- National Lime Association, <http://www.lime.org/>
- The Concrete Source, <http://www.concretenetwork.com/> See their web page for additional resources: <http://www.concretenetwork.com/links/organizations.htm>